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tive or a secondary character? If primitive, is it in a balanced or stationary condition, or is it in process of change? Secondly, is this a retrogressive or a progressive character? Questions to be answered certainly only by the evidence afforded by ontogeny or paleontology, and in a comparatively limited number of cases by comparative anatomy. Further, it may be necessary to ask: Is this a dominant character, or one which has attained such importance in evolution as to crowd out and overshadow all others?

Anatomical analysis, however, does not stop here; we must constantly be on the lookout for transitional characters or characters in the very act of change. These transitional or evolutionary characters appear at present to be of four kinds: first, *modifications*, or such as have been brought about during the life of the individual without necessarily being connected with germinal changes; second, *fluctuations*, or fluctuating variations, changes of degree or proportion which may be due either to somatic or to germinal causes, one of the most difficult problems in regard to fluctuations being to ascertain how much is germinal and how much is purely somatic; third, *saltations*, which are altogether germinal, or at least prenatal, in origin, including marked changes of kind, the 'sports' of Darwin and Galton, the 'discontinuous variations' of Bateson, and the 'mutations' of de Vries. Wide celebrity has been given to the word 'mutation' through the brilliant experiments and observations of de Vries, but the original significance of this term as employed by Waagen and Scott was a different one, and I think it probable that Waagen used it in the sense of determinate variation. Fourth, *rectigradation*, a new term with which I propose to characterize what in the year 1889 I described as 'definite variations'; it embraces changes which many writers have described as 'orthogenetic,' under the supposed law of direct change, usually in an adaptive direction, which is described as Orthogenesis; these probably are the 'mutations' of Waagen.

All the processes in column IV. are those which may be observed at the time or moment of observation in any organism, provided we

have sufficient keenness of perception or sufficient knowledge to discriminate between them.

The elements of comparison given in column V., on the other hand, relate strictly to questions of origin, or to the past and the future, also to questions of comparison. The first broad distinction of comparison is between I., Homologous, and II., Analogous characters. In a strict interpretation homologous refers only to those elements which are 'homogeneous' (Lankester), or have an actual similarity of origin or ancestry. Under analogous characters there is a simple distinction to be drawn between the results of parallelism and of convergence, terms which I maintain should be used in a somewhat stricter sense than they have been hitherto. Looking to the past and future, we have III., the non-analogous characters and the broad phenomena of divergence. Appreciation of animal divergence, or of divergence in special structures and organs, naturally belongs to the evolutionary period of anatomical thought; a period beginning with the branching system of Lamarck and continued in the still clearer perception of divergence in the writings of Darwin. I have elsewhere proposed to employ the term 'adaptive radiation' for the general phenomenon of divergence as observed in a single group, distinguishing such a group in process of divergence as a 'radiation,' either a 'continental radiation' where diverging on a large scale, or a 'local radiation' where diverging in a more restricted environment.

• It will be observed that while these ideas and terms are all evolutionary they are also *purely anatomical*, and restricted to anatomy. In a second communication the ideas and terms of modern evolution will be similarly treated.

HENRY F. OSBORN.

SOME PH.D. STATISTICS.

WE do not have to go very far back in the annals of higher education in the United States to discover a period when the percentage of instructors at a given university who had received the doctorate from the same institution, excluding foreign degrees, came perilously near the maximum. During the last ten or fifteen years, however, quite a change

has been effected in this respect, so that at the present day there are few prominent universities in the country where the number of faculty members who hold a Ph.D. degree from another university is not larger than the number of those who received the degree from the institution in which they are giving instruction. There has been a noticeable change during the past decade also in the percentage of degrees received from foreign universities, and while there has been no perceptible decrease in the actual number of degrees taken abroad, there has been of course a considerable increase in the number conferred by American universities. In 1884 only 28 Ph.D. degrees were granted on examination by American universities; ten years later (in 1894) there were 233, and fifteen years later (in 1899) there were 325.

Chicago, Columbia, Cornell, Harvard, Johns Hopkins, Pennsylvania and Yale are the universities that are turning out the largest number of doctors, and it may be of interest to know how these universities, as well as a number of other representative institutions of higher learning, stand in the matter of 'inbreeding.' In the following figures only instructors of professorial rank, having a seat in one or another of the university faculties, are considered. In only three institutions is the number of degrees received from the home university larger than that received elsewhere, namely, in the case of Yale, where 46 of the 67 professors holding the Ph.D. degree, or 69 per cent., received it from Yale and 21 from other institutions; in the case of Johns Hopkins, where 27 out of 41, or 66 per cent., received it from Johns Hopkins and 14 from elsewhere; and in the case of Pennsylvania, where 26 out of 45, or 58 per cent., received it from Pennsylvania and 19 from elsewhere. The other institutions from which figures were secured run in the following order, the figures representing in each case the number and percentage of professors who received the degree from the home university: Cornell 32 out of 70, or 46 per cent.; Columbia 32 out of 73, or 44 per cent.; Michigan 10 out of 25,

or 40 per cent.; Harvard 21 out of 55, or 38 per cent.; Princeton 12 out of 33, or 36 per cent.; Chicago 25 out of 86, or 29 per cent.; Wisconsin 13 out of 49, or 27 per cent.; California 4 out of 46, or 9 per cent. It is only natural that universities like California, Wisconsin and Chicago should have a high percentage of Ph.D.'s from elsewhere on their faculties.

The above figures also show that in the actual number of doctorates held by members of the faculties the universities rank in the following order: Chicago, Columbia, Cornell, Yale, Harvard, Wisconsin, California, Pennsylvania, Johns Hopkins, Princeton and Michigan. Chicago also has the largest number of Ph.D.'s from elsewhere, followed by California, Columbia, Cornell, Wisconsin and Harvard.

The following universities in the order named are represented by the largest number of doctors of philosophy at the institutions above enumerated, excluding in each case the degrees granted by the same university: Johns Hopkins, Harvard, Yale, Columbia, Princeton and Pennsylvania. Among foreign universities, Leipzig has by far the largest representation, having 37 doctors of philosophy on the faculties of the universities under discussion, as against 40 from Johns Hopkins. The other universities represented by more than one doctor follow in the order named: Göttingen, Halle, Berlin and Munich (10 each), Freiburg, Heidelberg, Strassburg, Jena and Rostock and Würzburg (2 each). Complete returns were not made by every institution, but the figures are close enough to reflect existing conditions with sufficient accuracy.

The statistics prove that most of the universities concerned attract to their faculties a considerable percentage of holders of Ph.D. degrees from other institutions, that Yale, Johns Hopkins and Pennsylvania are the chief exponents of 'inbreeding,' that the western universities, as might be supposed, draw the largest percentage of doctors from elsewhere, that Johns Hopkins has the largest Ph.D. representation of any American university,

and Leipzig of any foreign university, on the faculties of the institutions under discussion.

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BOTANICAL NOTES.

MICHIGAN FORESTRY.

THAT rational views as to forestry are steadily growing in popular favor is shown by the increasing attention which is given the subject by state and local organizations. The recent appearance of the report of the Michigan Forestry Commission forcibly emphasizes the changed attitude of the people with reference to the forests. Many years ago the writer was an interested eye witness of the lumbering operations which finally denuded the state of its fine forests, and at that time nothing that any one said had the least effect in staying the hands of the destroyers. There was but one thing to be done with the forests, and that was to destroy them. And now, alas, when it is too late to save even a remnant of the magnificent tree growth the public conscience has been awakened, and the enormity of the crime is beginning to be realized.

The report enumerates the steps taken by the commission in the campaign of education which it has inaugurated, and includes the report of the warden of the state forest reserves (Professor Roth), followed by a collection of essays by a considerable number of public-spirited citizens, all tending to create an interest in the planting or conservation of forests. The forest reserves include about 34,000 acres near Higgins and Houghton lakes in Crawford and Roscommon counties. Originally almost all of the land of these reserves was covered by heavy forest of pine, cedar, tamarack and some hardwoods. In a few striking sentences Professor Roth tells the story of the destruction of the great forest, and the transformation of the sylvan landscape into a dreary waste. It is a pitiful tale of greed for gain coupled with utter carelessness as to the future of the country. Photographs make very real the story he so graph-

ically tells. Yet other photographs give us a view of the more cheerful story which may be told in the future when the seedlings now springing up are allowed to grow into a new forest. If the fires are kept out these areas may again be covered with trees. To this end the commission is working, and in this laudable undertaking every scientific man in the country will wish them Godspeed.

A NEW BOOK ON ECOLOGY.

At last, after much delay, the University Publishing Company, of Lincoln, Nebr., has issued Professor Clement's book on 'Research Methods in Ecology.' An adequate review of this important contribution to modern botany will appear in due time, and it is only necessary to say now that it analyzes critically the problems which confront the practical ecologist (theoretical ecologists appear to have no such difficulties), and discusses the methods of solution with great detail, in which many illustrations and descriptions of instruments are used.

ORIGINAL DESCRIPTIONS OF SPECIES.

A. A. HELLER, of Los Gatos, California, has undertaken the publication of a series of fascicles in which appear the original descriptions of all of the North American species of certain genera of plants. He has already issued such fascicles for *Lupinus*, *Trifolium*, *Ribes*, *Castilleja* and *Artemisia*, including descriptions of 464 species. Each species is given a separate sheet, and the sheets for each genus are enclosed in special manila paper covers. The cheap price of these reprints (about one cent each) places them within the reach of all botanists who are interested in this department of systematic botany.

NORTH AMERICAN RUSTS.

PROFESSOR HOLWAY, of the University of Minnesota, has begun the publication of an important work on the rusts, entitled 'North American Uredineae,' of which Part 1 of Volume I. has just appeared. This part is a quarto pamphlet of 32 pages of text, accompanied with ten photomicrograph plates of